PSYCHOLOGICAL LITERATURE.

I.—NERVOUS SYSTEM.

On the Relations between the Function, Structure, Origin, and Distribution of the Nerve Fibers which compose the Spinal and Cranial Nerves, being the Marshall Hall prize oration. WALTER HOLBROOK GASKELL. Read May 24, 1888. Vol. LXXI of the Medico-Chirurgical Transactions of the Roy. Med. and Chirurg. Soc. of London.

In this "Marshall Hall prize" oration, Gaskell has reviewed his work on the nervous system since 1881. Taking this account of the author as a guide, it will be worth while to run over his important contributions, despite the fact that some of them are already several years old.

In 1881 Gaskell was able to show, by the use of a new method, that the vagus nerve not only inhibited the rate and force of the heart's beat in the frog, but was also able to accelerate the rate and augment the strength of the contractions (Proc. Roy. Soc. XXXIII, 1881–2). A special feature of the method used was a clamp by which any desired pressure could be applied between two portions of the heart, and thus an artificial resistance to the passage of an impulse from one part to the other introduced. This led to the discovery that the vagus nerve in the frog was in reality a vago-sympathetic, the vagus fibers causing inhibition, and the sympathetic acceleration and augmentation; that the two sets of fibers were present both in the tortoise and the crocodile, and that in all cases the accelerator fibers reached the heart by the same course as in the mammal (Journ. Physiol. Vol. V, 1884–5.)

Further, Gaskell was led to the view that the nature of the action of these cardiac nerves was directly on the muscle, and therefore inhibition is something taking place in the heart muscle itself, and is not to be explained by the interference of nerve action outside the muscle (Cong. période. internat. d. sc. méd. Compt. rend. 1884, Copenh. 1886).

If the after-effects of stimulation are considered, it becomes plain that the result of vagus stimulation is to put the heart muscle in a state of repair in which it is capable of doing more work; while the accelerator, by exhausting it, brings about an opposite condition. Regarding, then, principally the constructive action of the vagus, and the destructive action of the accelerator, they are designated respectively anabolic and katabolic nerves (Journ. of Physiol. Vol. VII, No. 1). This is the most extensive and perhaps the most important of these papers.

The notion of a double nerve supply, similar to that in the heart, to the different tissues of the body, was supported by the study of the muscular tissue of the rest of the vascular system, the muscular tissue of the alimentary tract and of glands, and has led to the suggestion that probably all the tissues of the body are supplied with anabolic and katabolic nerves.

The question as to whether tissues are supplied in this way is but another form of the question whether trophic nerves exist, using the term in its most general sense; and it is well known how much attention has been given to that question of late. The fact, too, is not without significance that those who are working with Gaskell, or under his direction, are at present studying this very point of the double nerve supply of the various tissues.

While these physiological ideas were being worked out, Gaskell made an anatomical observation that has been of fundamental importance to his work. On examining the sympathetic cardiac fibers going to the heart of the tortoise, he was much struck by the difference between them and the vagus fibers; the sympathetic fibers being unmedullated between the heart and the ganglion from which they emerge, while the vagus fibers are medullated throughout their course. Here was a distinct morphological difference between the anabolic and katabolic nerves, and further investigation showed that it held good for all animals examined. In studying these two sets of nerves, and following them back to their origin in the central system, he developed the large number of new facts and new points of view which are contained in the paper last cited. It was known that the accelerator nerves for the heart passed out in the anterior spinal nerve roots. On examining the upper dorsal and lower cervical roots in the dog, they were found to be free from non-medullated fibers. At the same time it was noticed that the anterior roots of the dorsal region differed from those of the cervical, in containing a group of very fine medullated nerve fibers. These very fine fibers were found to form the bulk of the white Ramus communicans by which the sympathetic ganglion was in connection with the central system.

The course of the accelerator fibers was then clearly in the anterior roots, where they were represented by a group of excessively small medullated fibers, thence to the appropriate ganglion, where the medullary fibers ceased and were continued on as non-medullated fibers. Further study showed that in the ganglia it was the ganglion cells that gave rise to the non-medullated fibers, and that the small medullated ones reaching the ganglion from the cord were in connection with these cells, the exact mode of connection not being worked out. When it is said, then, that these fibers lose their medullary sheath on passing through the ganglion, it must be remembered that, strictly speaking, the medullated fiber probably terminates in the ganglion cells in one way, while its physiological equivalent arises from these cells in quite another way. The anatomical difference between anabolic and katabolic nerves, then, depended on the point where the latter lost their medullary sheaths. This connection between the white Ramus communicans and the structure of the anterior root led to an examination of all the spinal roots in the dog, with the result of showing that only where these bundles of small medullated fibers were present are there any white Rami communicantes or homologous structures—in all other cases the Rami communicantes are non-medullated. It would necessitate a lengthy digression to give the facts presented in connection with the visceral ganglia, and they are here neglected, as it is of more importance to get at Gaskell's idea of what constitutes a complete segmental spinal nerve, and see the relations of his view to the interpretation of cranial nerves with which he concludes. This

much may, however, be said regarding the small medullated fibers: 1. A cervico-cranial outflow of them occurs in connection with the vagus and upper roots of the spinal accessory nerves. 2. A thoracic outflow occurs between the second dorsal and second lumbar roots; and 3. A sacral outflow occurs in the roots of the second and third sacral nerves.

This marked inequality in the outflow leads Gaskell to a number of other considerations. In the first place, the gaps between these outflows are filled up by the plexuses for the anterior and posterior extremities—a fact which receives no special interpretation. The limits of the outflows correspond so closely to the limits of Clarke's column of cells that in Gaskell's opinion they force one to the conclusion that this group of cells is connected with the visceral nerves. The very roundabout course of the constrictor nerves of some of the blood-vessels and of the sympathetic glandular nerves has here an explanation, for they all come apparently from the thoracic outflow, and, losing their medullary sheaths in the ganglia of the main sympathetic chain, pass in various directions to their destinations. "Further," he adds, "I was able to point out how this appearance and distribution of small medullated fibers corresponded to known facts as to the distribution of the nerves governing the muscles of the alimentary tract; how the known cases of vaso-dilator nerves and the secretory nerves of the glands were all characterized by the fineness of the caliber of their fibers and the presence of ganglion cells on their course; that in fact a large class of nerves existed of various functions which might all be called visceral or splanchnic nerves, all characterized by the fineness of their fibers, and by the peculiarity that, although *efferent* in function, they were in connection with ganglia in some part of their course."

Looked at from this standpoint, the sympathetic (so called) and homologous ganglia appeared, not as the representatives of an independent nervous system, but as ganglia occurring in the course of the spinal nerves, and belonging to that system as much as the posterior root ganglia belong to it. The study of these ganglia on the efferent fibers shows them to differ from those on the afferent, in the fundamental fact that the fibers which emerge from them are non-medullated, while those which emerge from the latter are medullated. A means of distinguishing between the two sorts of ganglia is thus given, and the distinctions are utilized when Gaskell discusses the ganglia on the cranial nerves.

Formulating these facts, Gaskell describes a spinal nerve as consisting of an anterior and posterior root, both of which are ganglionated, with this difference, that the ganglion on the posterior root is comparatively stationary, occurring near its origin, while the ganglion on the anterior root is vagrant, occurring as a rule at some distance from the central system. Moreover, these motor vagrant ganglia are in connection with a special group of fine medullated fibers.

Further, there are in all probability sensory nerves which supply the region over which the ganglionated efferent nerves are distributed, and these might be considered as forming a special group in the posterior roots. Still another subdivision was introduced by the consideration of the relation which these fine ganglionated visceral fibers bore to the groups of large motor fibers controlling respiration, deglutition and expression, which are found specially in the spinal

accessory and the vagus group. These large fibers thus associated with the small ones corresponded closely with Bell's group of respiratory nerves. Gaskell gets his explanation for this relation of things from certain researches by van Wijhe on the mesoderm segments in the head of selachians.

In this case there is a double segmentation into a dorsal and ventral series of muscle plates, the dorsal series being supplied by the third, fourth, sixth, and twelfth nerves, and a ventral series by the fifth, seventh, ninth, and tenth nerves. The muscles developed from this latter series were those of mastication, respiration, and deglutition, thus belonging to the respiratory group. These coarse fibers that are found associated with the fine ganglionated efferent fibers seem, then, to form a special group. Designating fibers as somatic or splanchnic according as they supply the dorsal or the ventral mesoderm segment of van Wijhe, a spinal nerve may be considered as composed of: 1. A posterior root with a stationary ganglion into which both somatic and splanchnic afferent fibers pass; 2. An anterior root composed of (*a*) a large fibered somatic and (*b*) a large fibered splanchnic portion, both of them non-ganglionated, and of (*c*) a small fibered ganglionated splanchnic portion, the ganglion of which is vagrant.

There are therefore three groups of fibers recognized in the anterior root and two in the posterior, the idea being best supported by the arrangement of the fibers in the upper cervical and lower cranial region.

The groups of cells in the cord are harmonized with this division of the nerves in the following manner. Dividing the cells into somatic and splanchnic, it is found that the somatic efferent and the somatic afferent arise respectively from the ends of the anterior and posterior cornua. The splanchnic afferent are supposed to have their center in the solitary cells of Schwalbe in the neck of the posterior horn. The non-ganglionated splanchnic efferent fibers seem to be connected with the cells of the intermedio-lateral tract situated in the lateral horn, while the small ganglionated efferent fibers are made to arise from the cells of the column of Clarke.

As the discussion of these centers of origin is, however, not fundamental to what is to be said on the homologies of the cranial nerves, it may be left at this point. In the study of the cranial nerves there are a few general points that serve as guides. A complete segmental nerve should exhibit the five groups of fibers just enumerated. It must be determined whether the ganglia on them are stationary or vagrant. It must also be borne in mind that the ventral roots do not need to run free of the stationary ganglion, but may even run through it, as, for example, is the case with the first two cervical nerves of the dog.

Gaskell does not consider his work on the cranial nerves as yet complete, but is willing, nevertheless, to put forward some general conclusions. In the first place, the olfactory, optic, and auditory nerves are left entirely out of consideration. The remaining nine nerves seem to fall into two groups: 1. A foremost group, which in man is almost entirely efferent, namely, the oculomotor, trochlearis, motor part of the trigeminal, abducens and facial; 2. A hindermost group of nerves of mixed character: sensory part of the fifth, glosso-pharyngeal, vagus, spinal accessory, and hypoglossal.

The nerves of the first group resemble the anterior roots of spinal

nerves, in that they contain the three groups of fibers considered as typical. Gaskell is inclined to count them, however, only as four nerves, the abducens being regarded as the somatic portion of the motor part of the trigeminal. This foremost group of nerves also resembles a typical spinal nerve in its posterior root, in that they have a ganglion near the place of exit of the nerve from the central system. This ganglion, and the fibers connected with it, are in all cases phylogenetically degenerated, and a characteristic arrangement of connective tissue is all that is left to show where the nerve structures have formerly been. For the third, fourth, and seventh this condition is shown by figures of sections in an accompanying plate. This group resolves itself, therefore, into four segmental nerves, the afferent parts of which have undergone degeneration. In the second group above named there has been no loss of any part, but there is at the same time considerable dislocation of the various components, so that it requires some rearrangement to recognize the five segmental nerves which Gaskell considers to exist here. His statement of the case is this:

"1. The ascending root of the trigeminal, together with the auricular branch of the vagus, contains the somatic afferent nerves. The ganglion for these nerves is mainly the Gasserian ganglion.

2. The ascending root of the glosso-pharyngeal and vagus nerves contains the splanchnic afferent fibers, with the ganglion jugulare for its stationary root ganglion.

3. The hypoglossal, and probably part of the spinal accessory, form the somatic efferent portion.

4. The large motor fibers of the glosso-pharyngeal (?), vagus, and spinal accessory in part form the splanchnic non-ganglionated efferent fibers.

5. The small fibers of the glosso-pharyngeal, vagus, and spinal accessory, with the ganglion petrosum glosso-pharyngei and the ganglion trunci vagi for their motor ganglia, form the splanchnic ganglionated efferent fibers."

From these facts it is plain that the cranial nerves are built upon the plan of the spinal nerves, but are divisible into two groups, the meaning of which is yet to be made out.

Thus far what has been presented has been almost directly quoted from this last article of Gaskell. In calling attention, now, to those points in the argument for which the evidence appears insufficient, or is contradictory to apparently well established results, it is proper to speak only in the most general terms. There is certainly a gap that needs filling, between what has been determined for the anabolic and katabolic nerves of the heart and some other organs and the generalization that all the tissues of the body have a similar double supply. The voluntary muscles at once present themselves as a problem in this connection, and thus far two sets of nerves have not been shown for them. It is, perhaps, suggestive that all those cases in which the double supply is known to exist are in organs not under the control of the will. The association of the small white fibers in the anterior nerve roots with the cells of the column of Clarke, on the basis of the coincident extent of the two structures, is a view so very contrary to that now held concerning the connections of Clarke's column, that it must be supported by stronger evidence than that presented before it can hope for acceptance.

There is, further, no example of the typical spinal nerve as it has

been described. The typical nerve is a composite made up from the consideration of nerves at several levels, and finds its best exemplification in the cranial region which is apparently most modified. The central termination of the other two splanchnic groups has but very little positive evidence in favor of it thus far. In explaining the homologies of the cranial nerves, it is without doubt the nerves of special sense that are the most difficult to bring into line; but it certainly is an open question whether any arrangement of the nerves which leaves them out of account, as that of Gaskell does, is to be looked on as more than tentative. Supposing, however, that these criticisms should be supported by the results of future experiments, there would still remain a most important mass of information which has been the direct outcome of Gaskell's work. In the first place, the idea of anabolic and katabolic nerves, whatever the extent of its application, has a very considerable explaining power. To the neurologists, however, the fact that the so-called sympathetic nervous system can be shown to be an integral part of the spinal system, and not something independent, is of the utmost consequence; for not only is it a distinct anatomical advance, but, like all well grounded anatomical ideas, it disposes of much antiquated physiology of the region. The light which these ideas throw on the cranial nerves has certainly made it possible to attempt some order among this difficult group, and whether Gaskell is exactly on the right track or not, it seems clear that their illuminating power has not been exhausted.

Anleitung beim Studium des Baues der nervösen Centralorgane im gesunden und kranken Zustande. Dr. HEINRICH OBERSTEINER. Leipzig und Wien: Toeplitz & Deuticke, 1888.

In discussing a book that thus purports to be an introduction to the study of the central nervous system, the present state of the literature must be kept in mind. With the development of histological technique, the finer anatomy of the brain and cord began to be studied, and accordingly the last thirty years embrace most of the papers on minute structure. Of course this branch has been subject to the same laws that apply to all histological work, and the rapid increase of contributions in the later years of this period has been enough to appall any author contemplating a book that should represent the present state of knowledge on the subject. The disconnected character of the majority of the contributions which state the anatomical conclusions of the author and leave to some future compiler to knit the results together with those of others, is but the consequence of the comparative absence of general notions under which these special observations can be classified, and of course makes compilation most difficult. Various authors have attacked the problem in different ways. Schwalbe has produced something like an encyclopaedia of the subject. Henle, Meynert, and Wernicke have given rather individual accounts, less controlled by the views of others than is desirable in a manual. The excellent "Zehn Vorlesungen" of Edinger lacked sufficient detail for use in the laboratory, and, it should be added, was not intended for that purpose. There was room therefore, and need as well, for a book that should give a general view and yet contain sufficient detailed description to be used in the laboratory beside the microscope. No doubt Obersteiner is not the first man who has felt the desirability of such a